SMA SOLAR ACADEMY
Be a solar expert

Basic Seminar - Inverters

Be a solar expert

Organizational Matters

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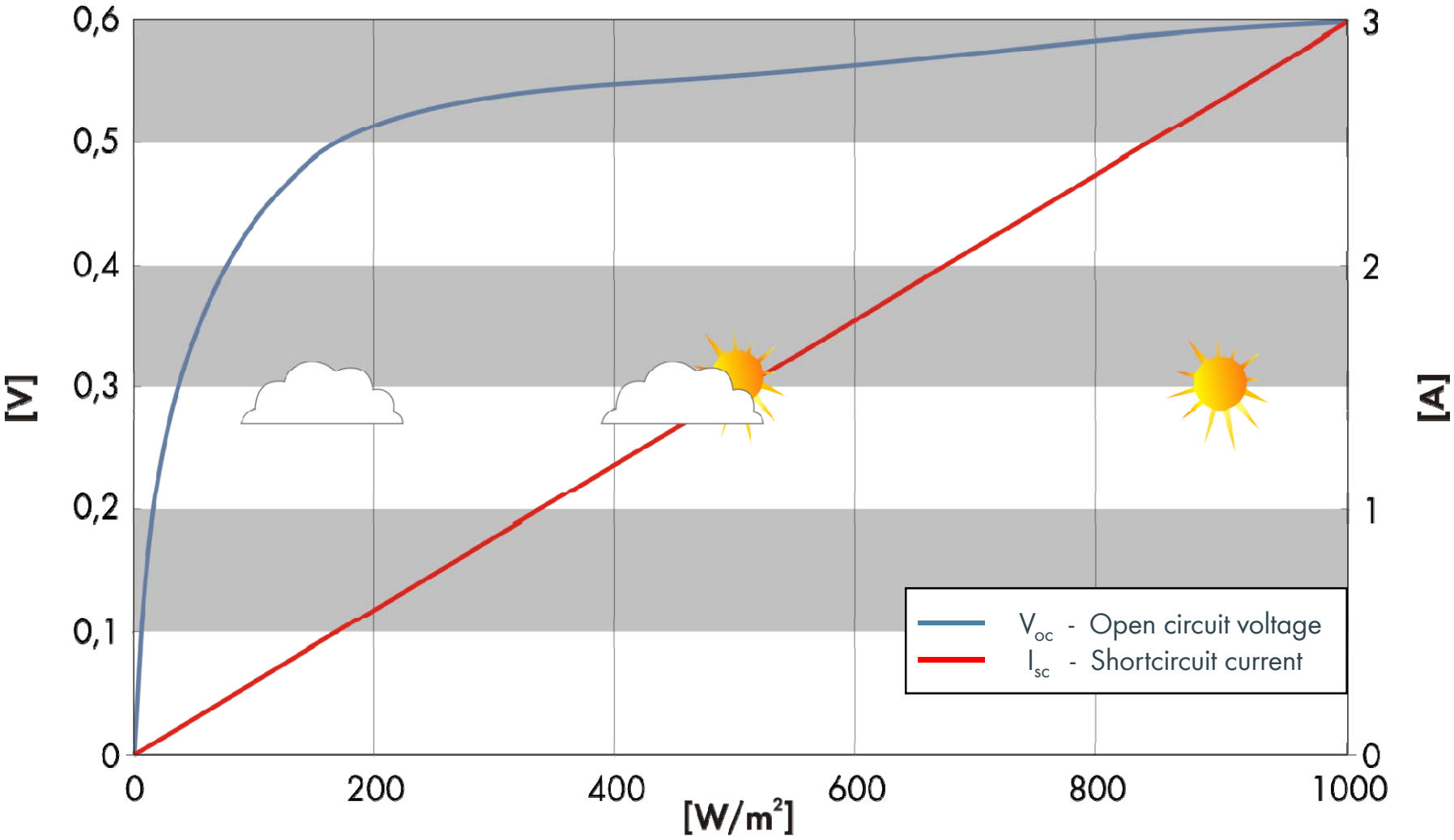
- Download areas:
  - http://www.SMA.de/handout

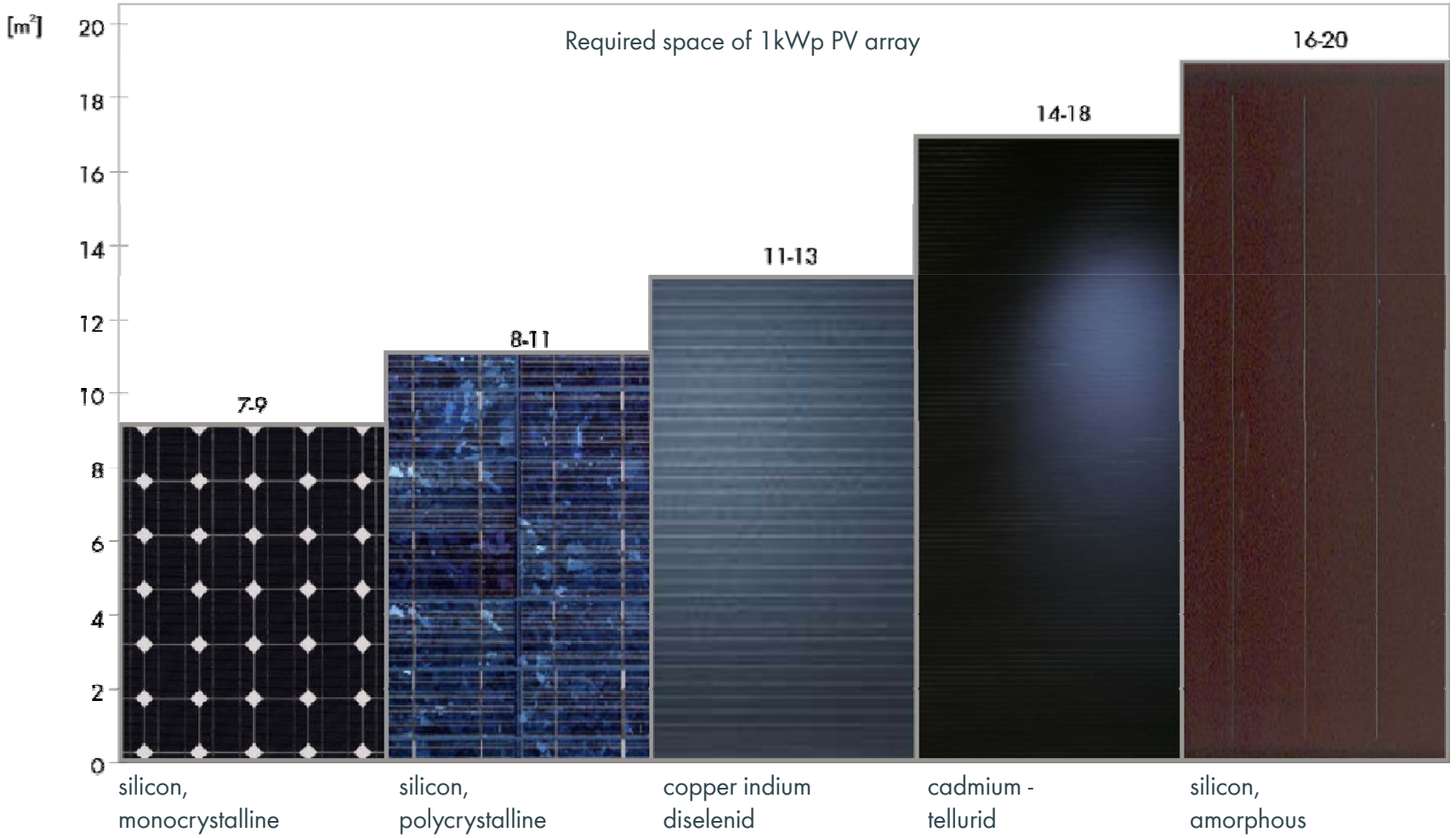
What to expect today...

- Basics of photovoltaics
  - Solar irradiation conditions have an impact on the yield
- The features an inverter needs to have
- Installation and electrical connection
- SMA inverters
  - Features
  - Product portfolio
- Objectives of plant monitoring
- Communication interfaces
- Sunny Data Control/Sunny Explorer presentation
- Direct communication with one inverter

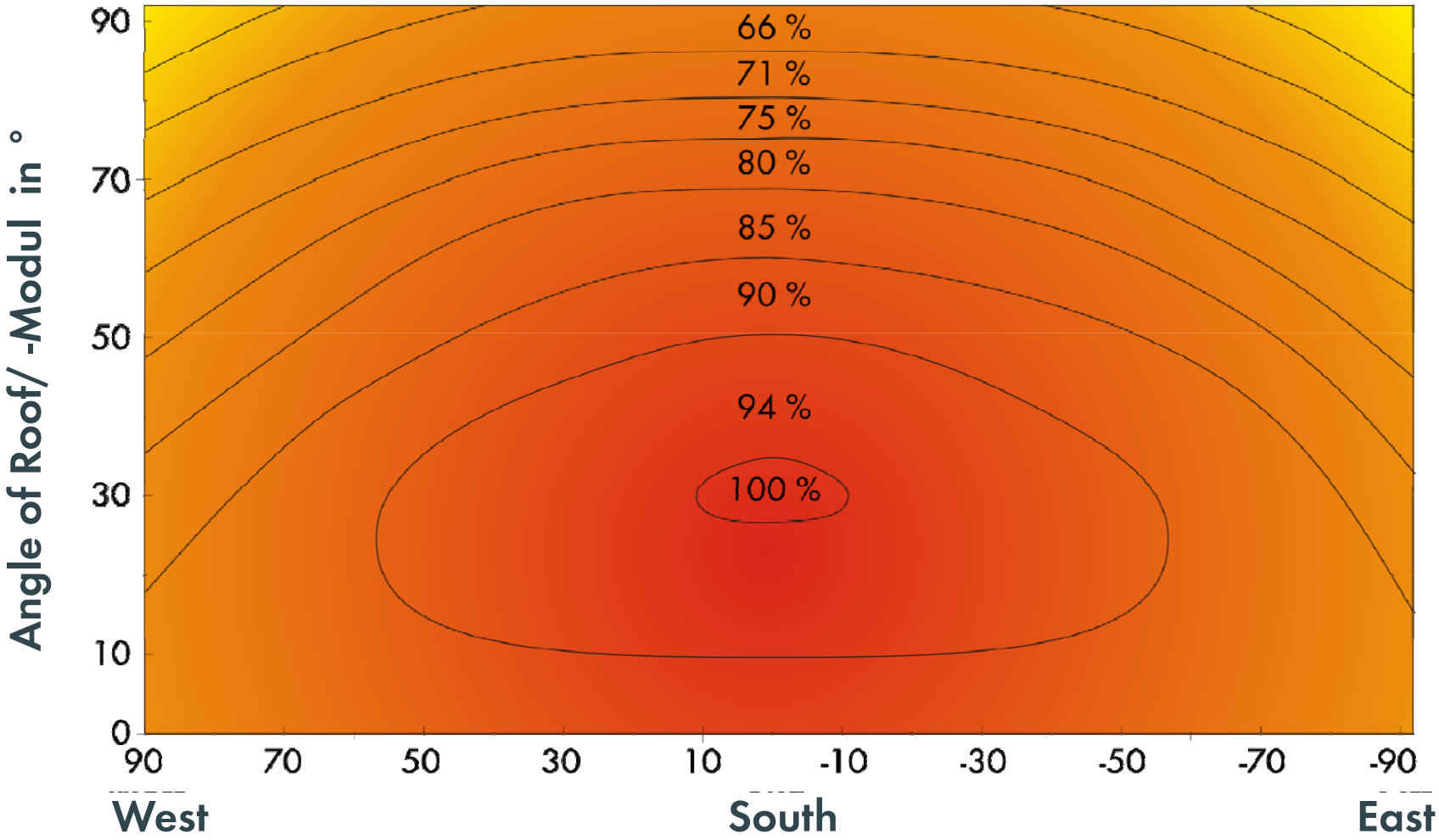
Current/voltage characteristic curve of a PV cell



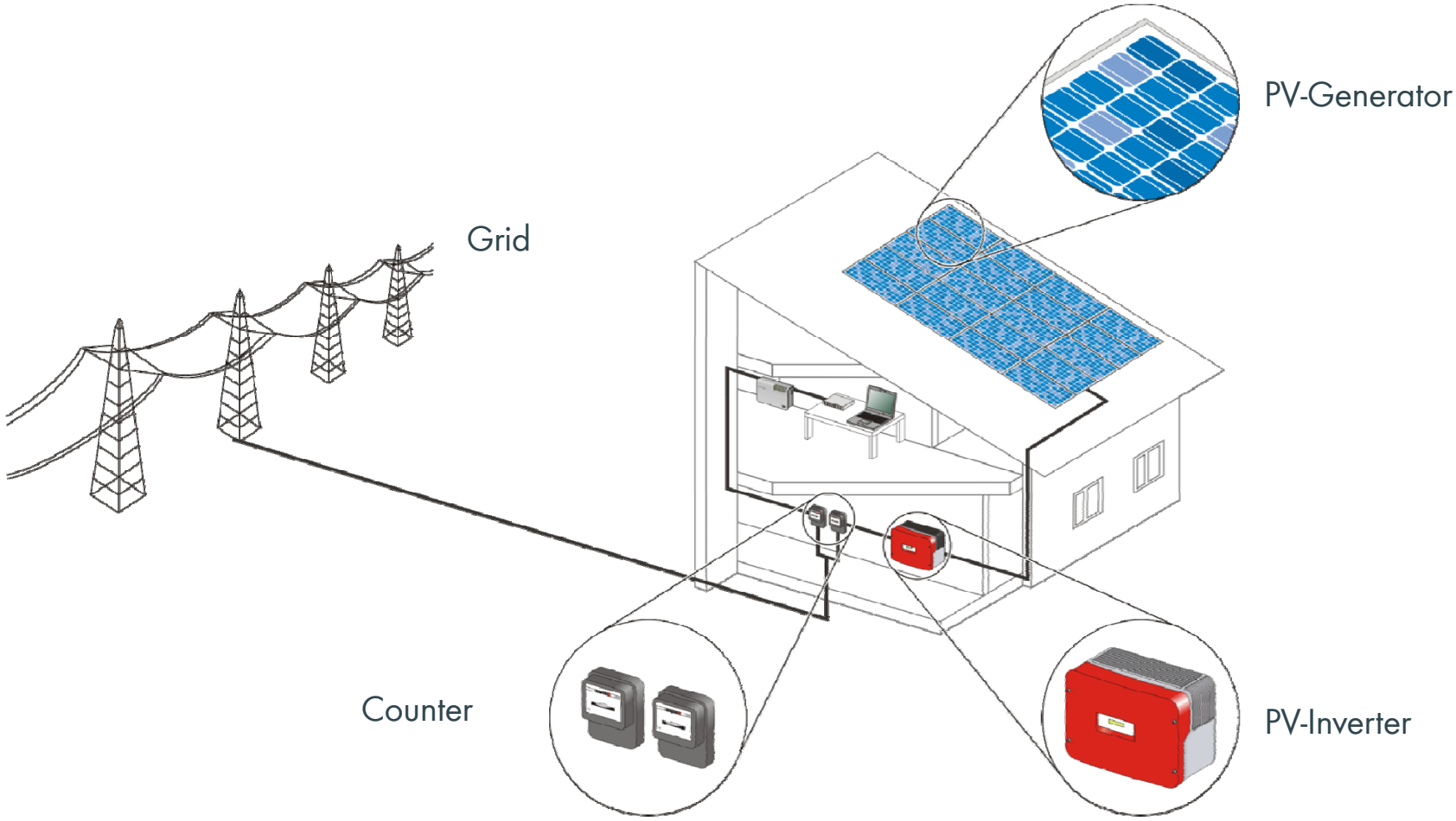
Surface requirements of different module types



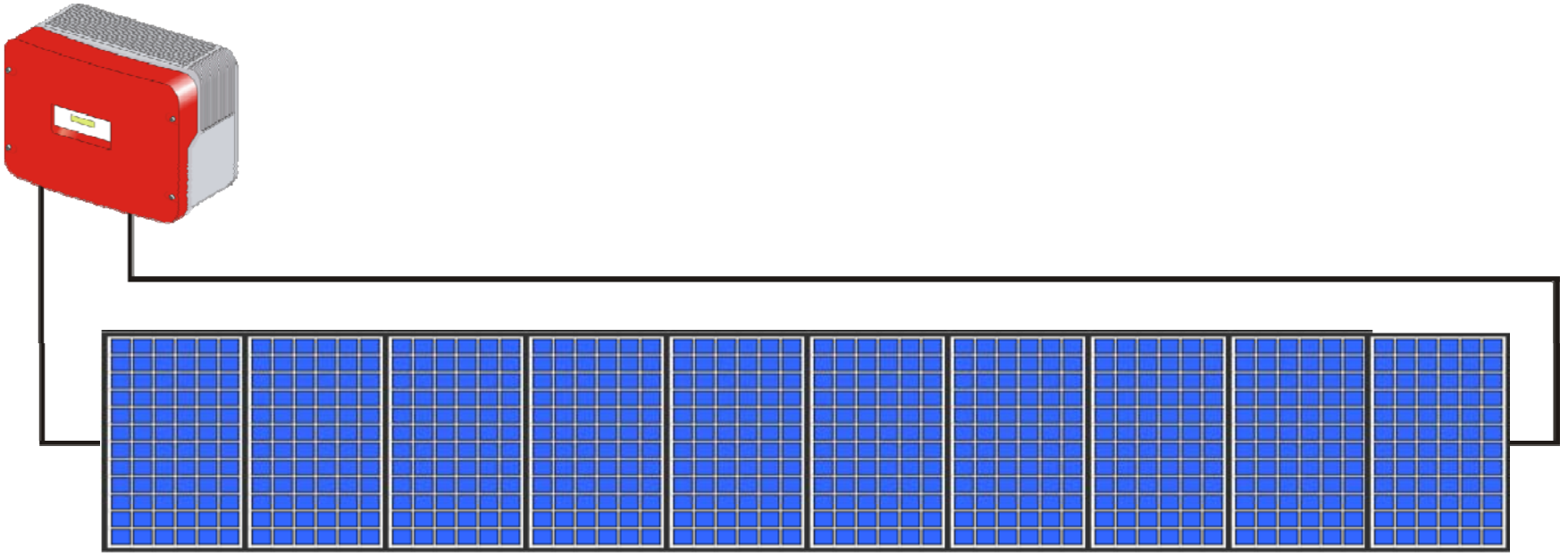
Relative yield in dependence of the module alignment



Principle of a grid-tied PV plant



What is a string?



> String - PV modules connected in series

> PV generators often consist of several strings

The features an inverter needs to have...

- High system efficiency
  - Fast finding and holding of the Maximum Power Point (MPP)
  - High efficiency also during partial load operation

- Easy functional control
  - Detailed plant monitoring
  - Easy fault diagnosis

The features an inverter needs to have...

- Maximum reliability
  - High protection rating, e.g. IP 65 due to robust enclosure
  - Large temperature range (–25°C to +60°C)

- Reasonably priced
  - Good price-performance ratio
  - Easy installation

- Modularly applicable - the ideal solution for small- and large-scale PV plants

What has to be taken into account during mounting

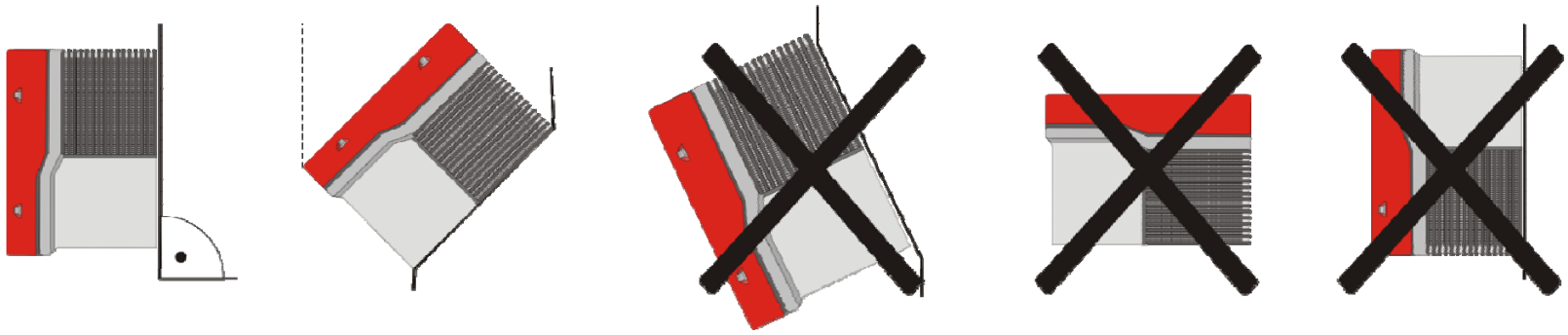
> Mount on a solid, non-flammable surface only

> Ambient temperature range between –25°C and +60°C

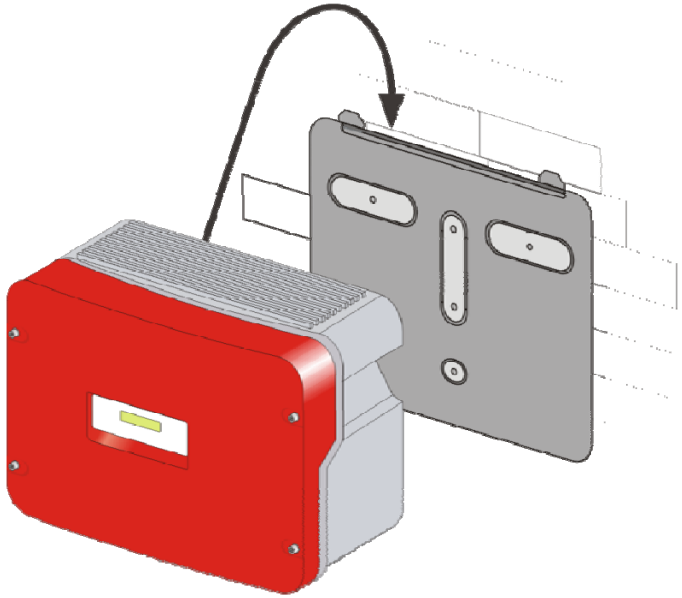
> A free space of at least 300 mm to 500 mm around the enclosure guarantees an optimum ventilation; if necessary, use a forced fan ventilation

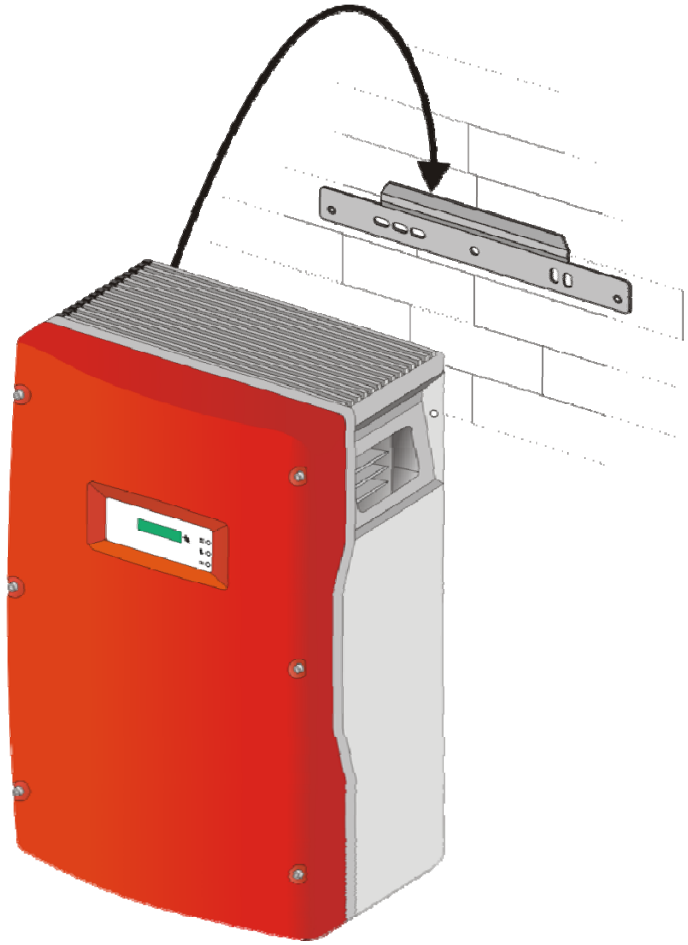
> Notice! Risk of burns. The heat sink can reach a temperature of 85°C

> Take the admissible mounting brackets into account: (see installation guide)

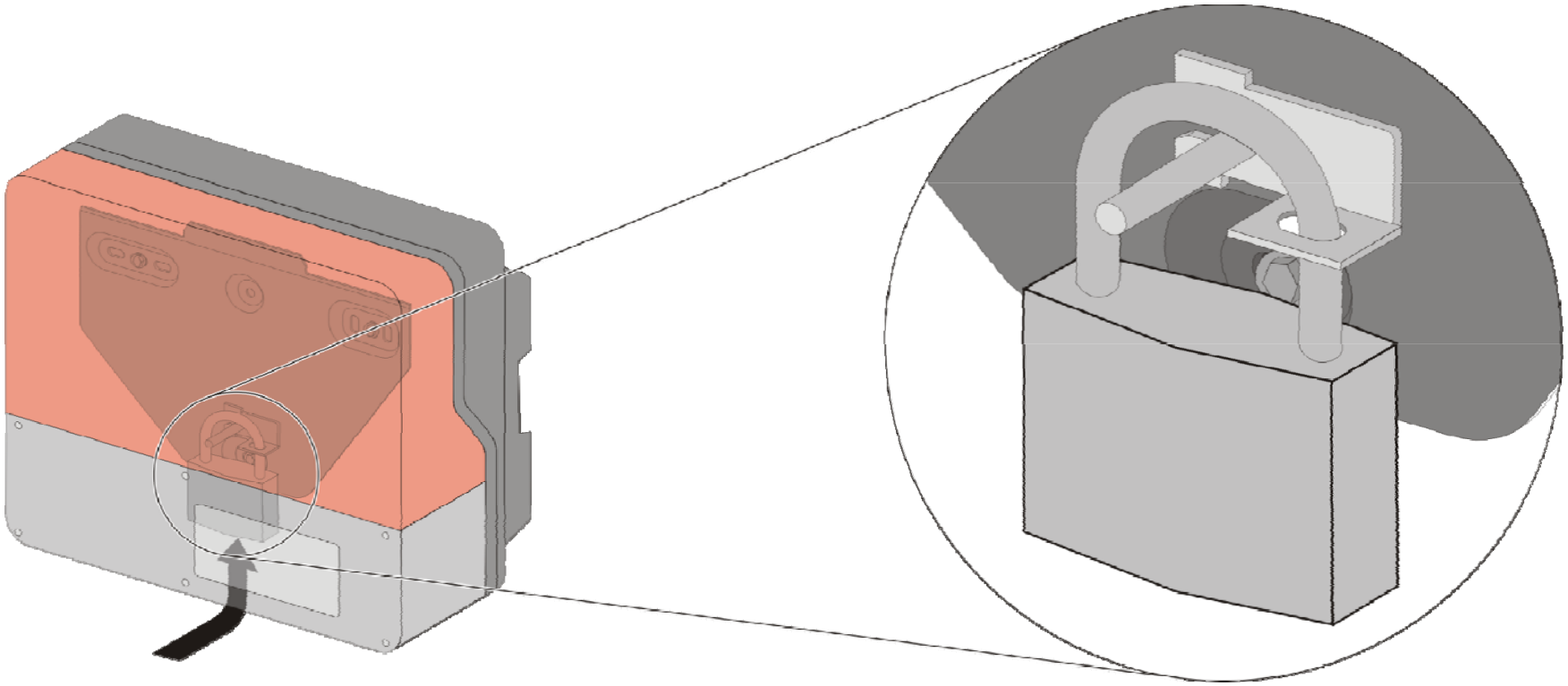


How to install Sunny Boy and Sunny Mini Centrals





Inverters from SMA are in great demand...



Optimum anti-theft protection for the Sunny Boy 3000/4000/5000TL-20

Important facts to know about your inverter

> Only work at the device when it is disconnected

  > Observe the heat sink's temperature!

> Work may only be carried out by qualified personnel

> Read the installation guide and the user manual

> Follow the installation- rules!

  ⓘ Cut of the AC- connection

  ⓘ Make shure for take on the AC while operation

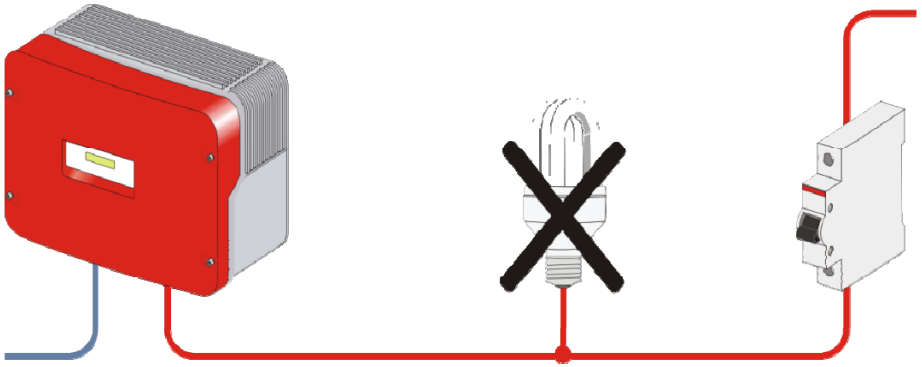
  ⓘ Check the AC and DC side free of Power

  ⓘ Connect it to earth with a short brake

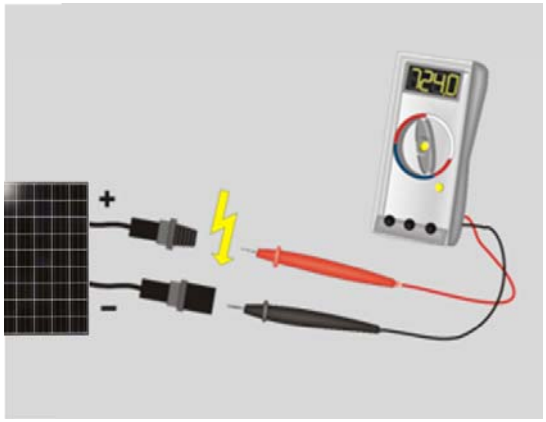
  ⓘ Take care and cover all nearly parts under power

Electrical connection: AC side

- Minimizing the cable resistance:
  - avoids the disconnection of the inverter
  - reduces line losses
- Fixed terminal and screw connections avoid the risk of fire within the wiring
- Secure all inverters via a proper line circuit breaker
  (see Technical Information for determination)
- Do not connect any further loads to the power circuit

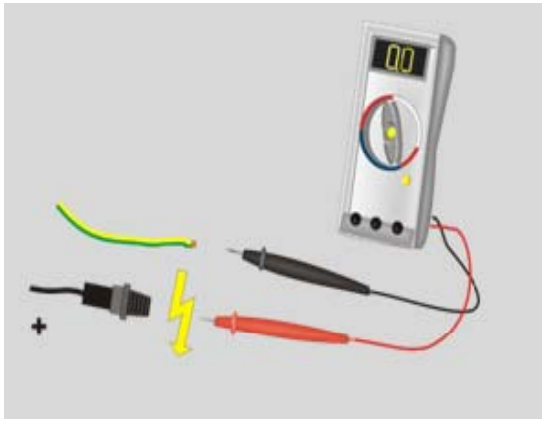


Electrical connection: DC side



> Checking the PV generator
>> voltage and polarity

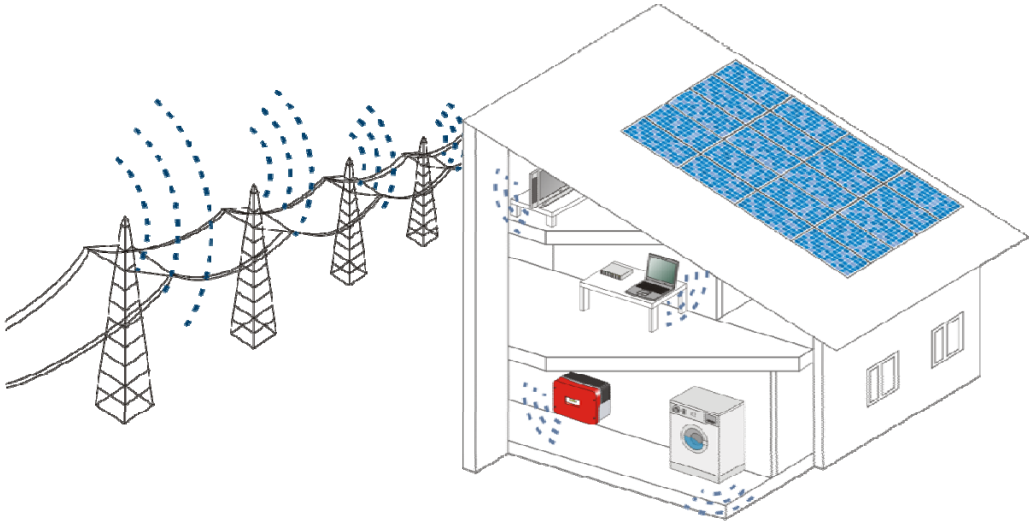
> PV generator voltage < maximum input voltage of the inverter



> Checking the voltage of the PV generator connection to PE
(DC "+" against ground, DC "–" against ground)

> Integrating the module frame and rack of the PV generator into the potential equalization

Which standards must be taken into consideration?



> Electromagnetic Compliance (EMC) according to EN 61000-6-1, EN 61000-6-2, EN 61000-6-3 and EN 61000-6-4

> Personal protection according to DIN VDE 0100 and DIN VDE 0105

> Grid monitoring according to DINVDE 0126-1-1

SMA inverters automatically monitor...

Grid monitoring according to VDE 0126-1-1

> Voltage	184 V to 264.5 V
> Frequency	47.5 Hz to 50 Hz
> Islanding detection	

> DC feed-in	max. 1 A
> Residual current	max. 30 mA
> Discharge current	max. 300 mA

You can change the limiting values with your personal access code (Grid Guard Code).

SMA grounding set for inverters with transformer

> Reduction of installation costs
due to device-internal grounding

> no effects on the plant's EMC behavior

> no irritation through continuous illumination
of the ground fault display

> The grounding provides high system safety
via internal thermal fuse

> Ground fault display is only activated in the
event of a tripped fuse

> Can be upgraded by the installer

Design rules for grounding

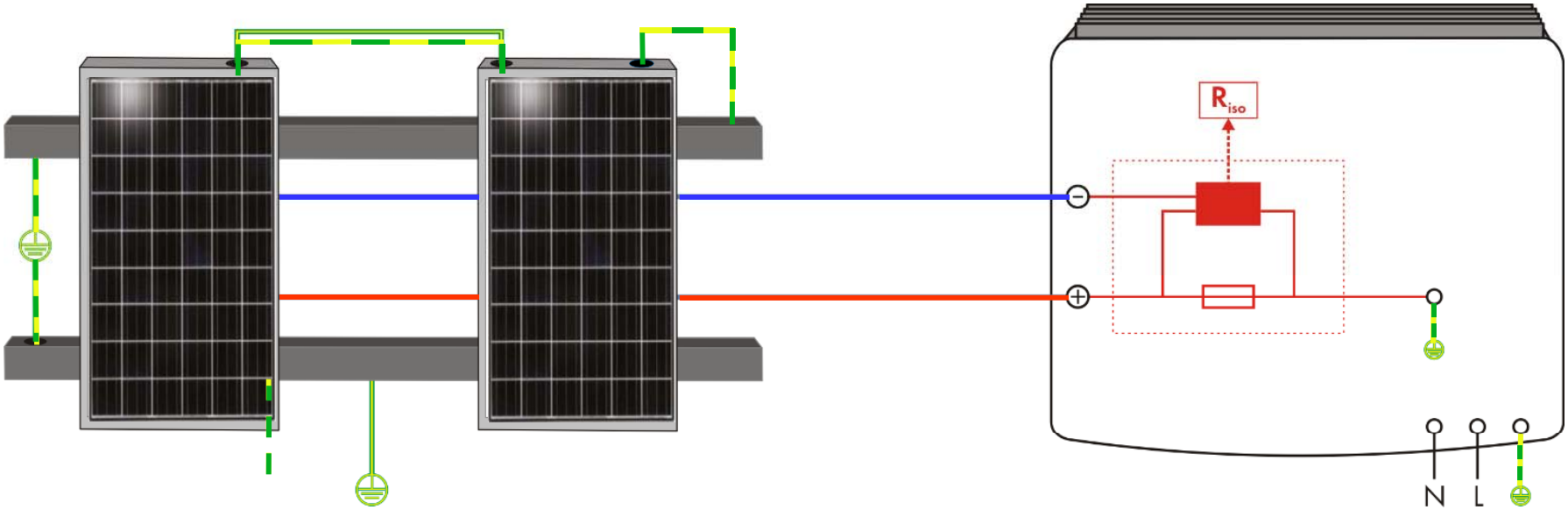
Which inverter for which module technology:

Cell technology/ module design	transformerless inverters		Inverter with transformer		
	SB xxxx TL SMC xxxx TL	SB xxxx TL-HC	Series device SB xxxx SMC xxxx	with negative grounding set	with positive grounding set
monocrystalline Si	■	■	■	□	□
polycrystalline Si	■	■	■	□	□
CdTe	↓	↓	↓	■	↓
amorphous Si (superstrate design)	↓	↓	↓	■	↓
amorphous Si (substrate design)	■	■	■	□	□
CIS	■	■	■	□	□
monocrystalline Si (A300)	↓	↓	↓	↓	■
Metal foil as substrate or in module design	↓	■	■	■	■

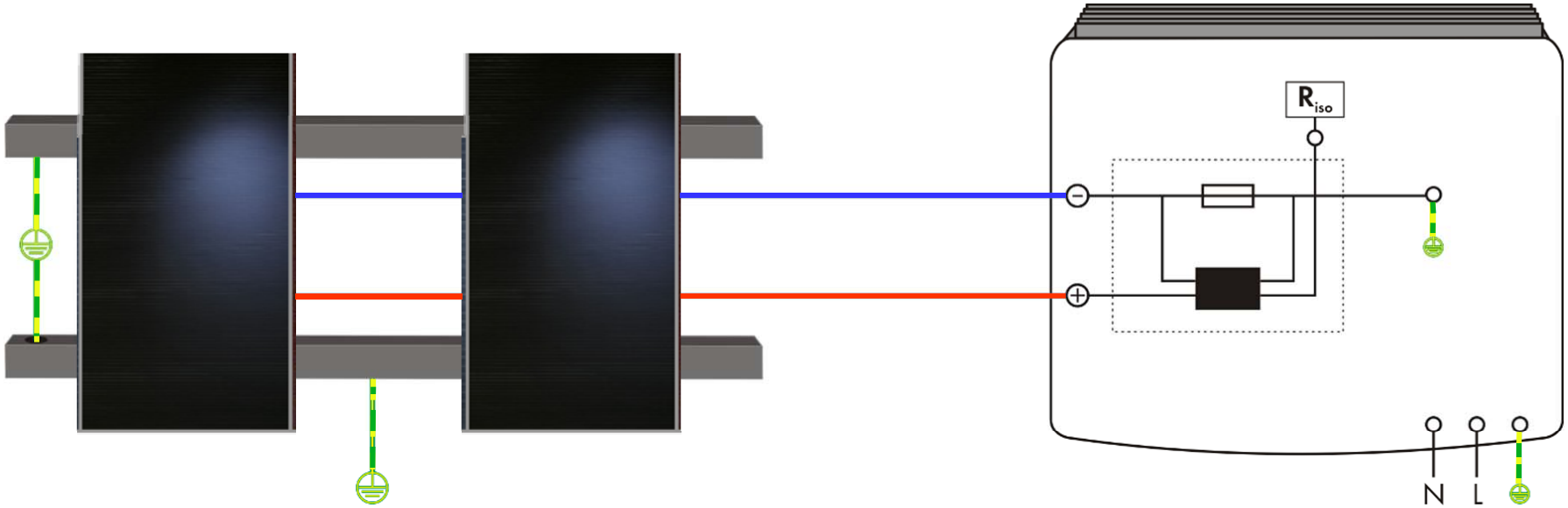
Legend:

■ is recommended □ is recommended with restrictions ↓ not recommended

Grounding/potential equalization



Grounding/potential equalization



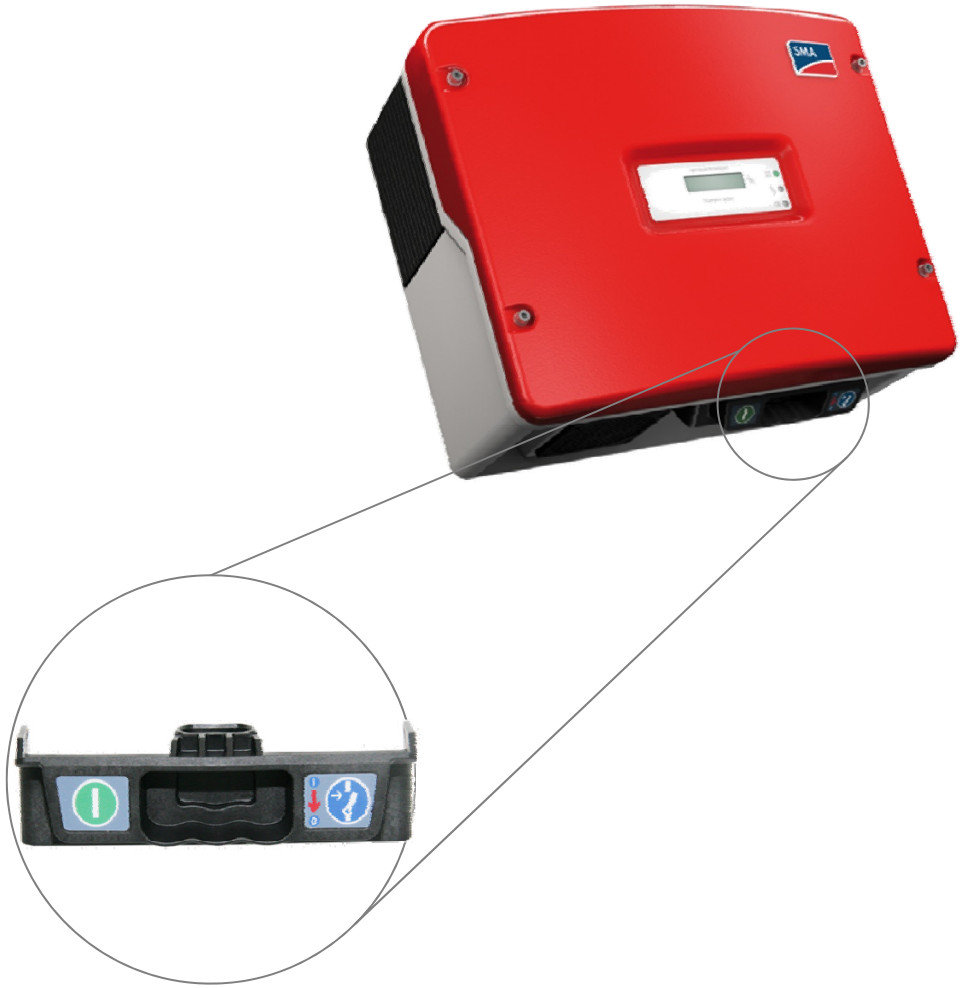
With or without transformer

	Transformer Inverter	Transformerless Inverter
Ground fault monitoring	continuous	continuous
Display of a ground fault	Red LED	Red LED
Effects of a ground fault	Inverter continues feeding in (can be set)	Inverter switches off immediately

Integrated protection technology in every inverter

ESS Electronic Solar Switch

> without any losses
> no additional installation required
> complies with DIN 0100-712 in terms of a DC switch-disconnector



Intelligent cooling – OptiCool®

> Maximum energy yields, even at high ambient temperatures

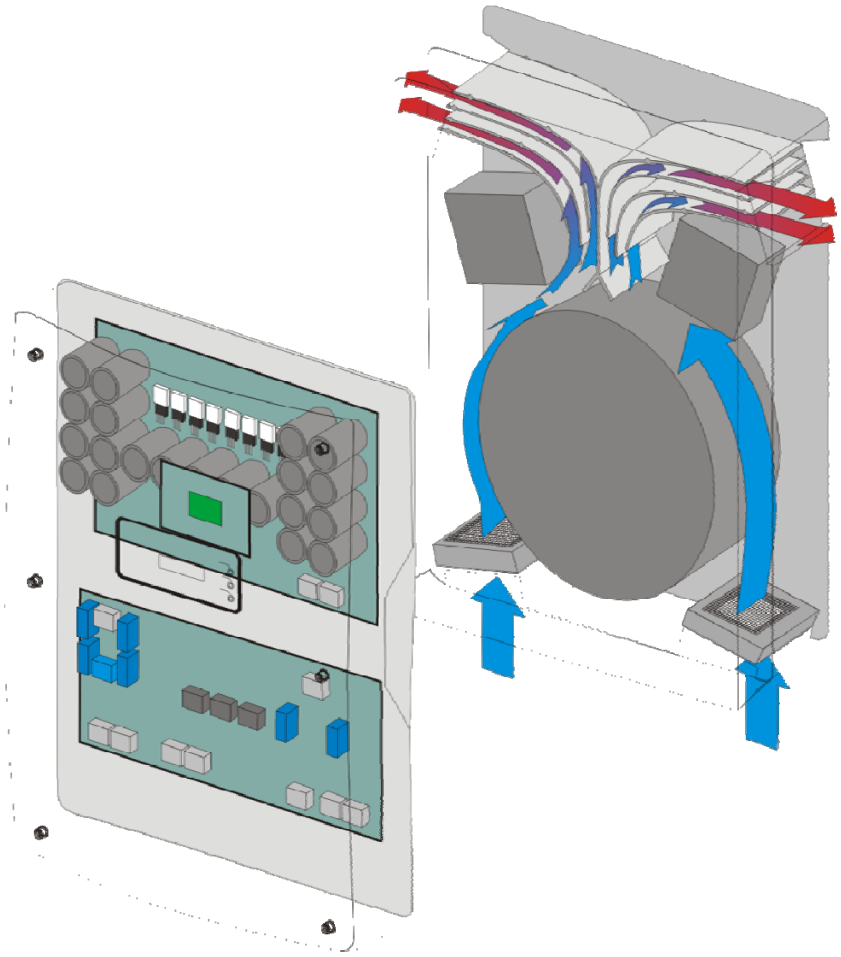
> Durable - lower fatigue of the components

> Safe - combined passive and active cooling

> Optimum protection against dust and water due to sealed

> electronics compartment

> Intelligent cooling - for all installation locations



Avoids unbalanced loads - Power Balancer

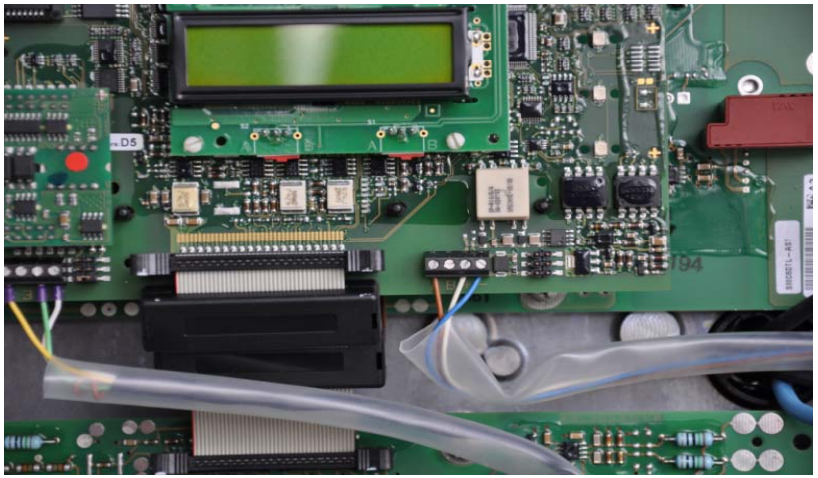
> Power Balancer in all SMC (single-phase)

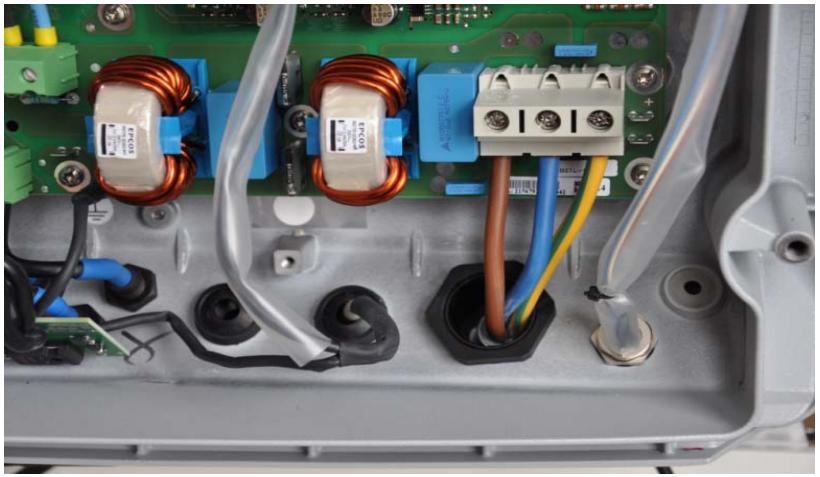
> Minimized yield losses

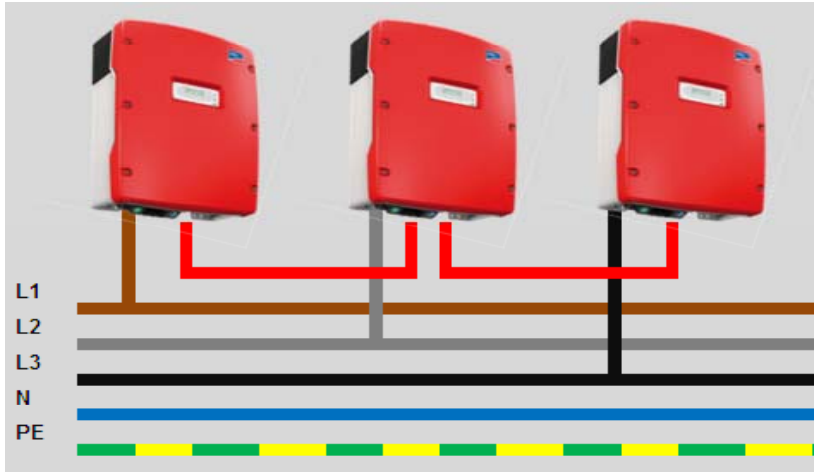
> Optimum control by four different settings
  > Off
  > Phase Guard
  > Fault Guard

> You can change the settings with your personal access code (Grid Guard password).

Power Balancer connection

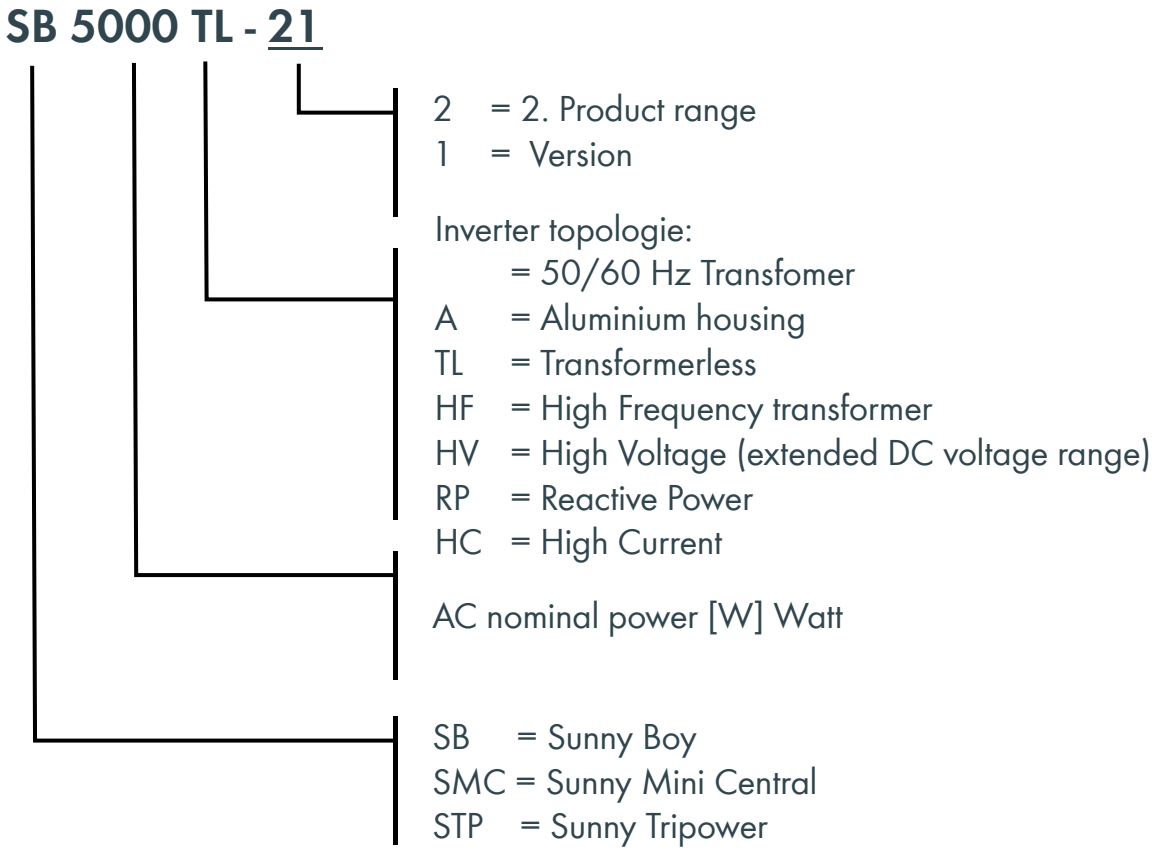






What does the product designation consist of?

Example:



SMA inverters

Sunny Boy 2000HF/2500HF/3000HF

New generation of galvanically

isolating inverters

- Topology: HF transformer
- Plug-in grounding set
- Max. DC voltage: 700 V
- Max. AC power: 2000 W/2500 W/3000 W
- Quick Modul

SUNNY BOY 3000HF - easy generator grounding

Plug-in grounding set

- Installation: plug in - that's all!
- Easy:
  - One set for both polarities
  - Fuse are replaceable
- Safe:
  - Inverter controls the polarity
  - Fault protection through integrated fuse

The test winner – SB 3300/3800

> Test winner at the German Product Standards Institute Stiftung Warentest 5/2006

> Highly flexible - positive and negative generator grounding is possible

> Highest yields thanks to OptiTrac and OptiCool®

The all-rounder – SMC 4600A/5000A/6000A

> Highly flexible - positive and negative generator grounding is possible

> Highest yields thanks to OptiTrac and OptiCool®

Optimally suited for thin-film modules - SMC 7000HV-11

> Highly flexible - positive and negative generator grounding is possible

> Highest yields thanks to OptiTrac and OptiCool®

> Ideally suited for thin-film modules and crystalline cells thanks to the maximum DC input voltage of 800 V

> Future-proof thanks to reactive power capability (international requirements)

Highest yields – SMC 6000TL to 11000TL

> Highest yields thanks to OptiTrac, H5 technology and OptiCool®

> Highest yields due to a maximum efficiency of 98%

> String fuses in 9000TL, 10000TL, 11000TL devices are optionally available.

SMC 9000TLRP to 11000TLRP

> Highest yields thanks to OptiTrac, H5 technology and OptiCool®

> Highest yields due to a maximum efficiency of 97.7%

> Future-proof thanks reactive power capability (international requirements)

Highly flexible - SB 3000/4000/5000TL-21

> Maximum flexibility due to Multi-String® technology

> Highest yields thanks to H5 technology and OptiCool®

> Very easy installation: cable connection without tools

> Flexible system planning

> Highest yields due to independent MPP trackers

SUNNY TRIPOWER – Future-oriented Planning

- > 3-phase power supply line: 3/N/PE, 230/400 V
- > More simple design options
- > Simplified approval processes
- > Grid management included
- > Compatible with the BDEW directive (Germany)
- > Easy realization of large-scale projects with medium-voltage feed
- > Future-proof thanks to reactive power capability (international requirements)

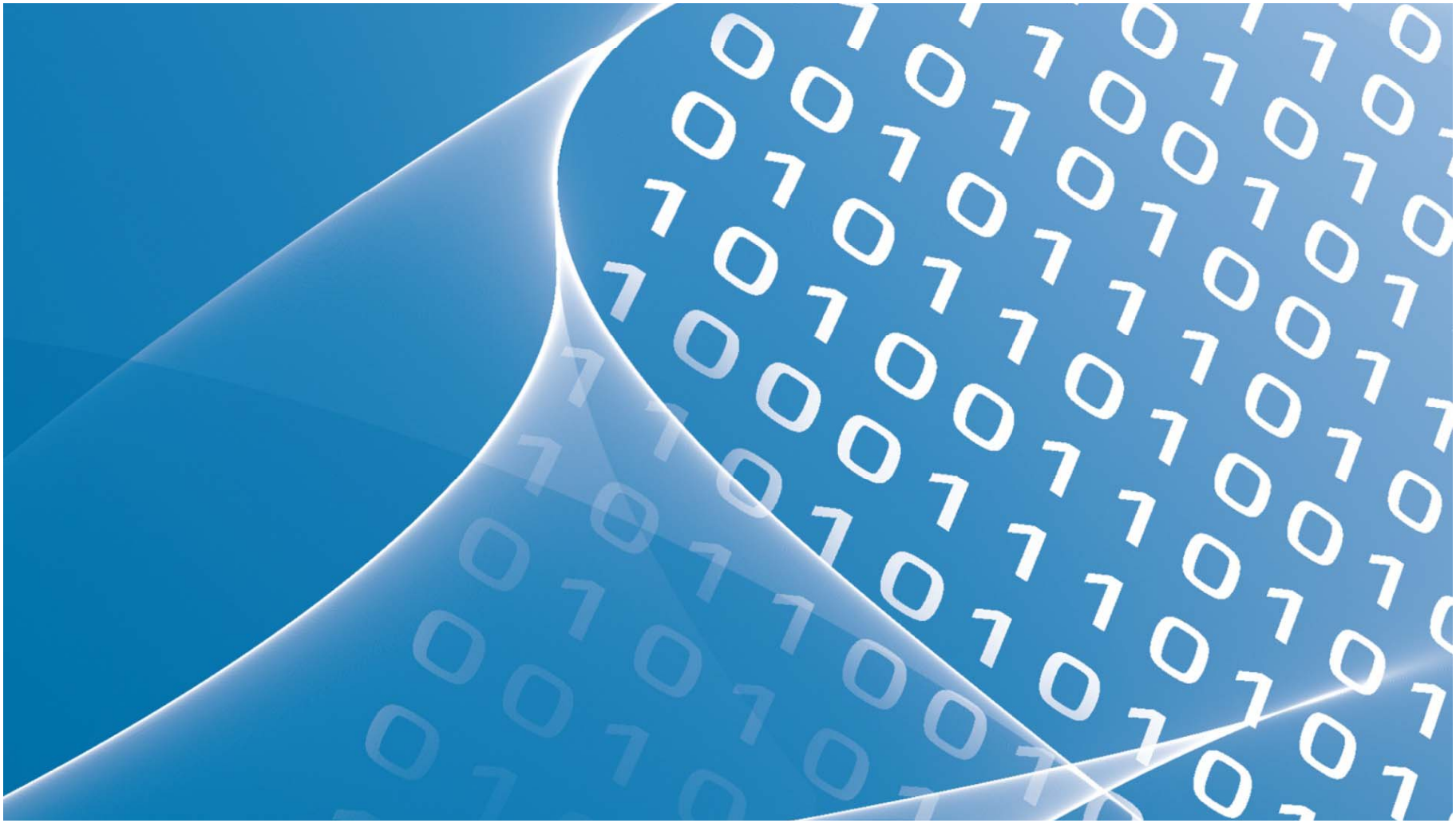
SUNNY TRIPOWER

- > DC input voltage of up to 1,000 V
- > Especially safe thanks to the Electronic Solar Switch
- > Highest yields thanks to OptiTrac and OptiCool®
- > DC overvoltage protector (type II) can be integrated
- > Cable connection without tools
- > Highest yields due to a maximum efficiency of 98%

"SUNCLIX" – New DC plug system

> Comfortable and fast due to connection without tools
> Universal for flexible and fixed conductors ranging from 2.5 to 6 mm²
> High conductancy with 40 A already with 4 mm² up to 85 °C
> Secure interlocking using click connections
> Easy to unlock with a standard screwdriver - even if plugs are close together
> Cost-effective due to field connector included in delivery

Plant controlling



Objectives of plant monitoring

- Check
  - Energy production
  - Display of instantaneous values, e.g. feed-in power
  - Continuous recording of plant data
  - Graphic presentation of recorded data
  - In case of an operational failure, signaling is guaranteed by the connection of warning devices on-site or by telecommunication
  - Early detection of operational failures

- Control
  - Optimization of device parameters, e.g. to adjust the disconnection criteria (consulting your electric power company will be necessary!)

Display LED

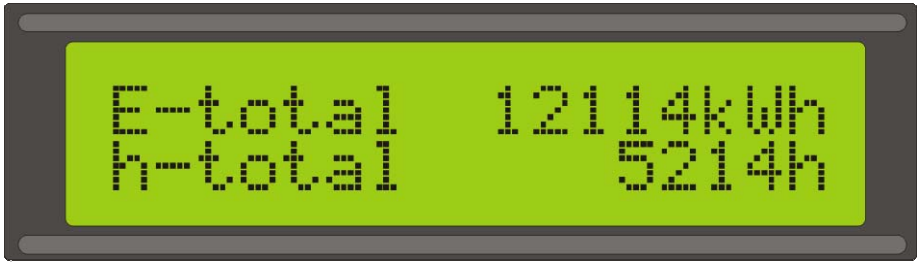
The most important at a glance - Sunny Display

> Current feed-in power

> Generator voltage

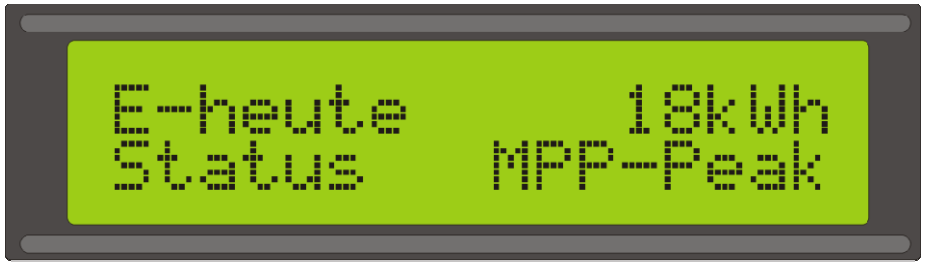
> Total energy produced

> Operating time in hours



> Energy fed in today

> Current operating state

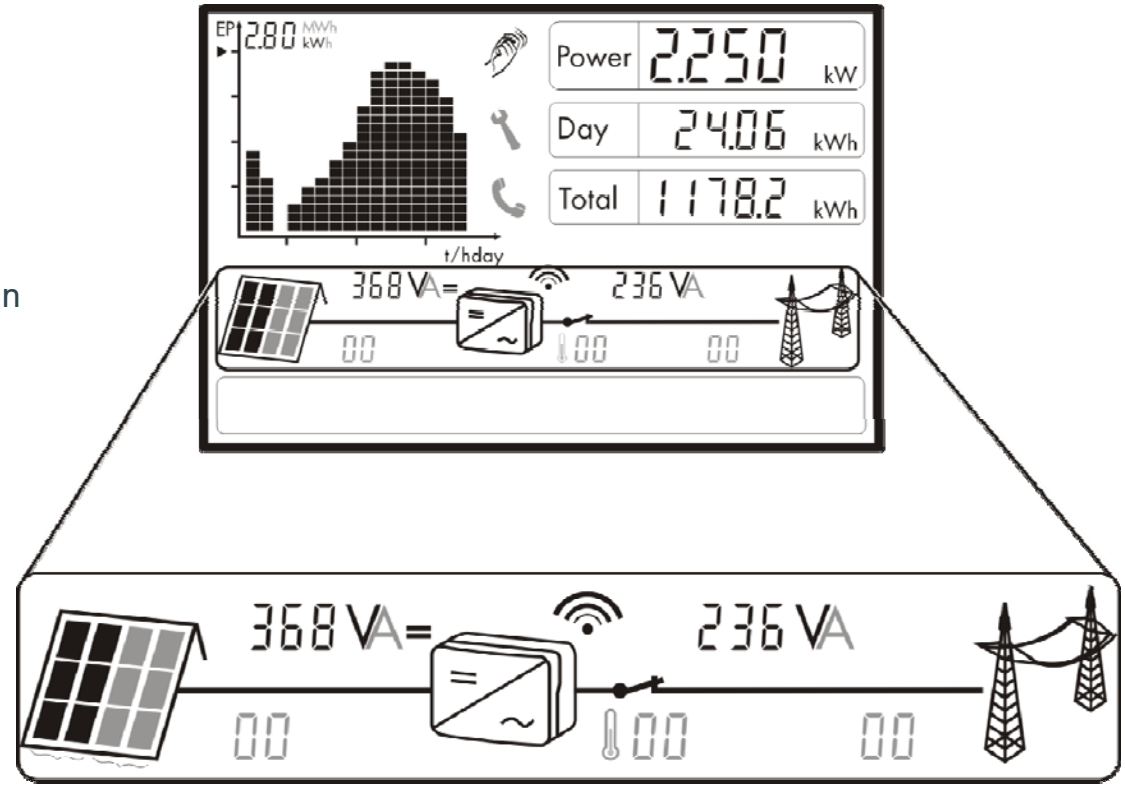


> Tapping activates the display illumination

Display "New Generation"

The following data is shown in the display:

- > Current output
- > Daily energy
- > Total energy generated since installation
- > Graphic presentation of the output
- > PV voltage/current
- > Grid voltage/current
- > Event number
- > Power reduction

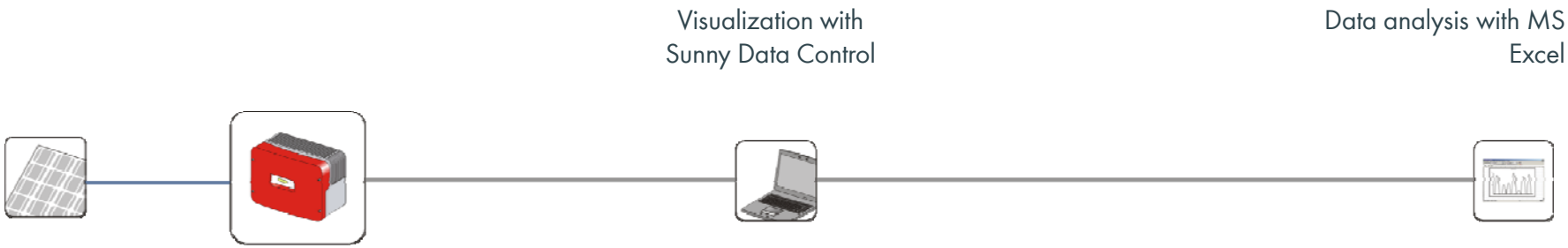


Overview of communication types

	USB service interface	RS485	Bluetooth
max. range	2 m	1200 m	100 m
max. number of devices	1	50	12 / 50
Transmission medium	Data cable	Data cable	Radio

Data transmission USB service interface

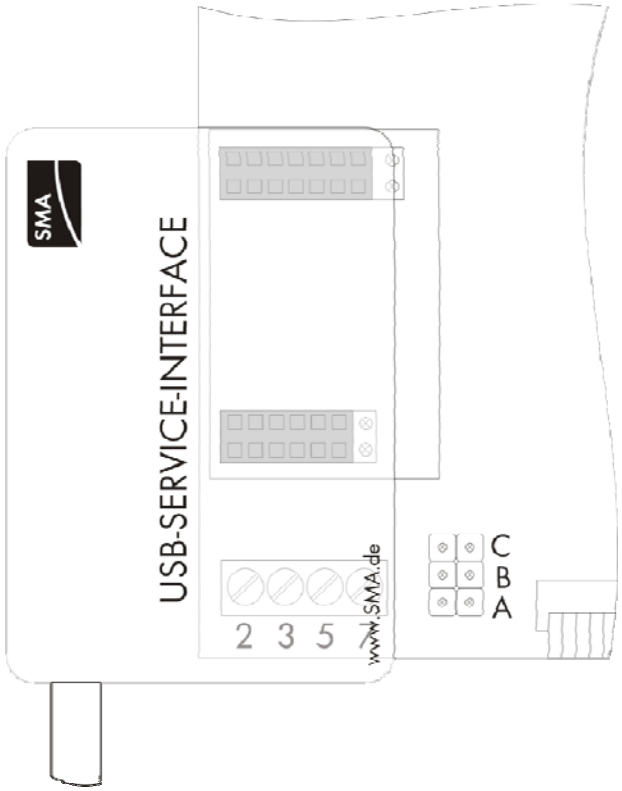
> Data transmission with max. one inverter



Requirements for the USB service interface

> USB service interface in inverter and communication connection to the display device

> PC software, e.g. Sunny Data Control 3.93



Everything under control - Sunny Data Control

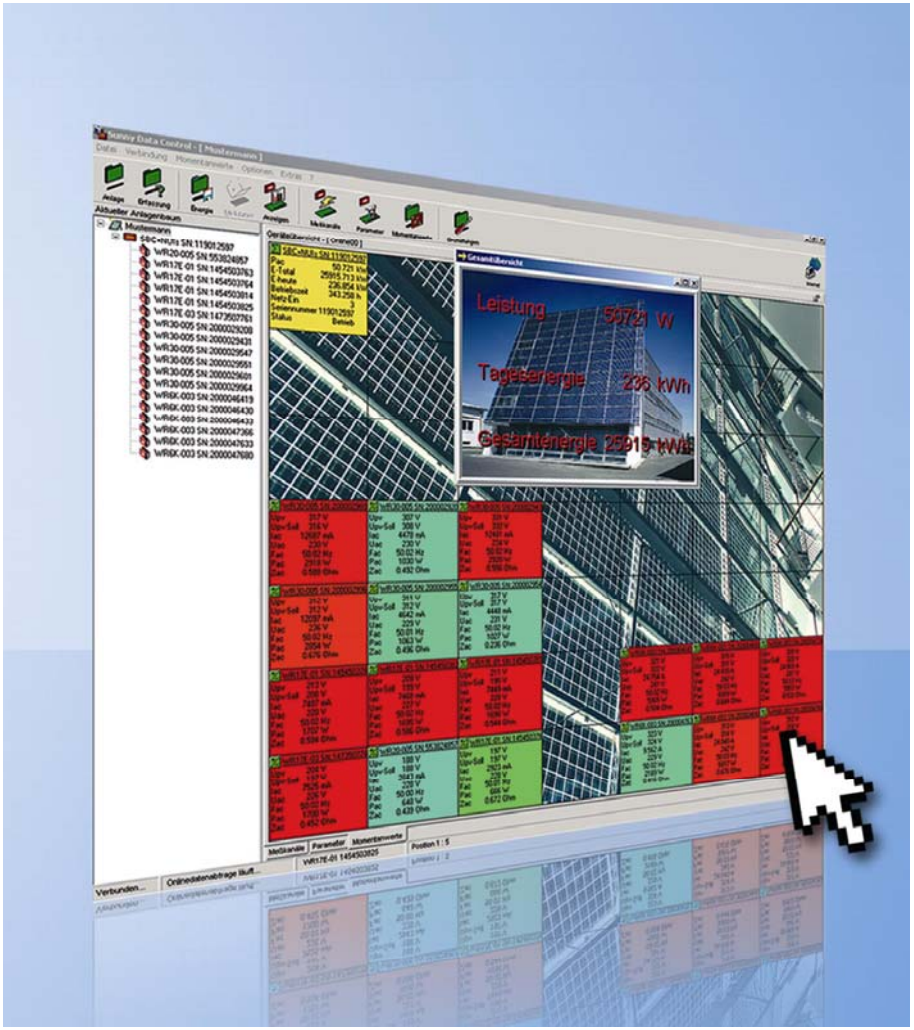
Download free of charge at www.SMA.de

Access, archive and evaluate

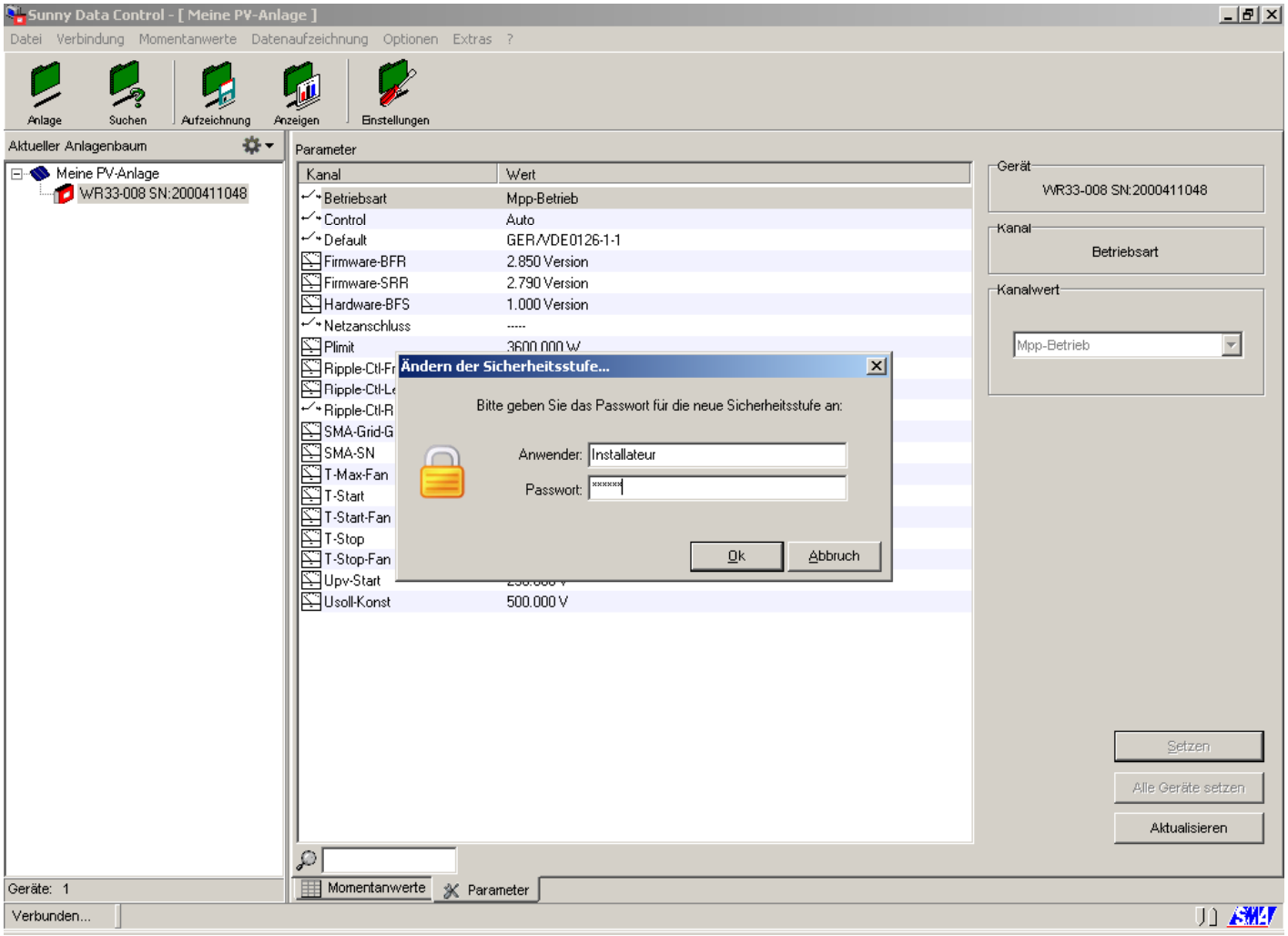
> Saving plant data

> Setting parameters, even without data logger

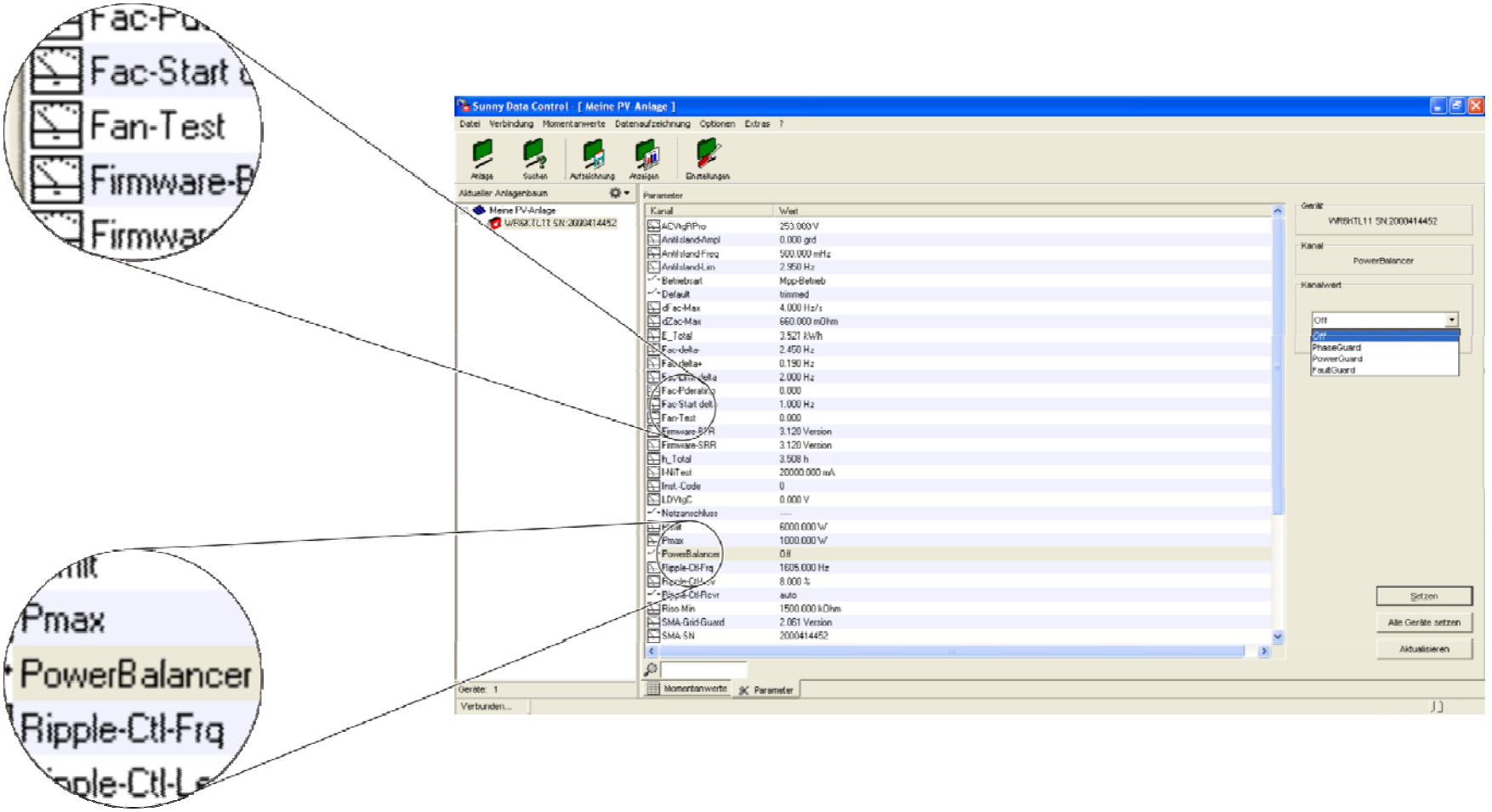
> Evaluating plant data with MS Excel



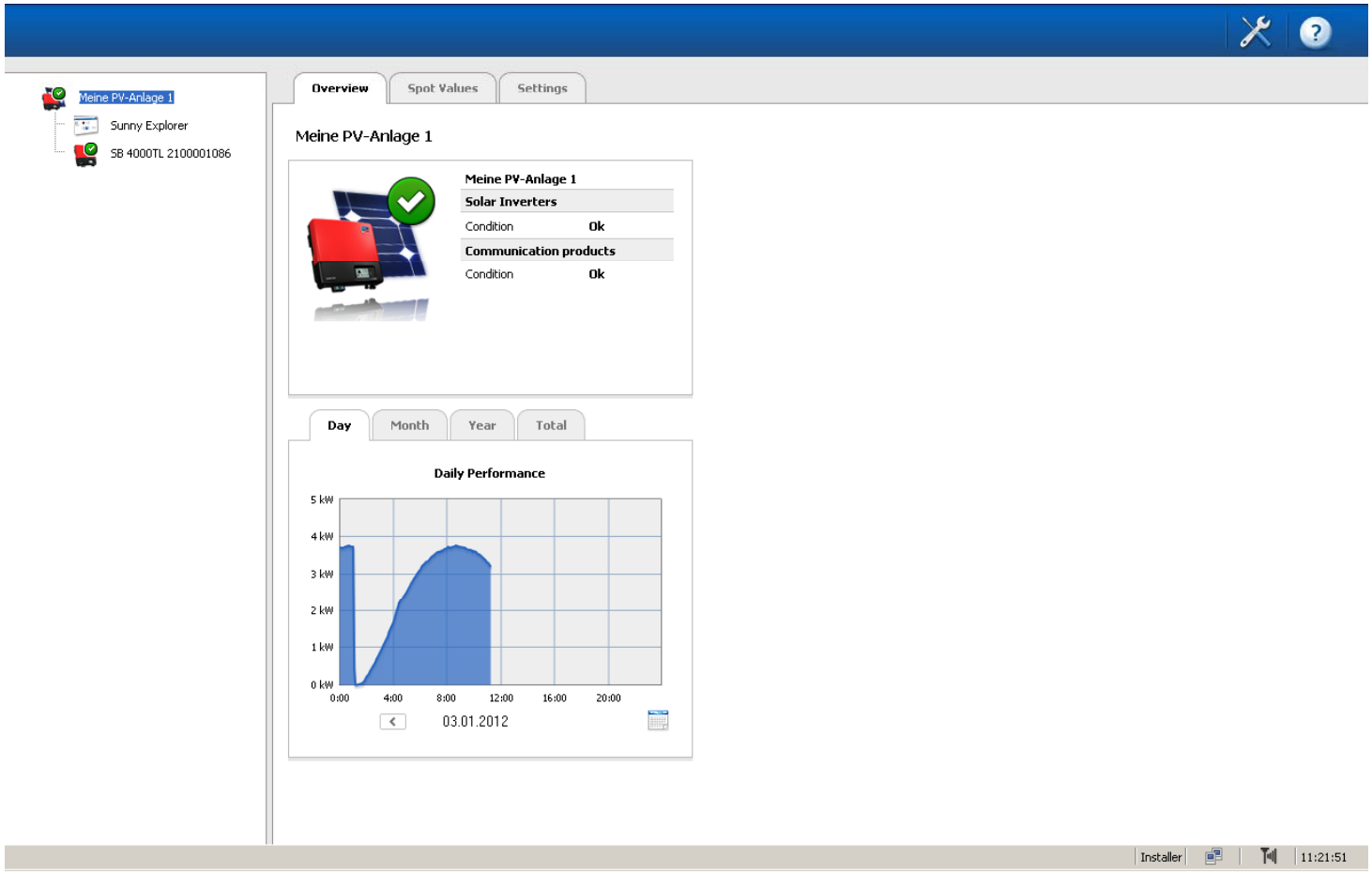
Security level - user authentication

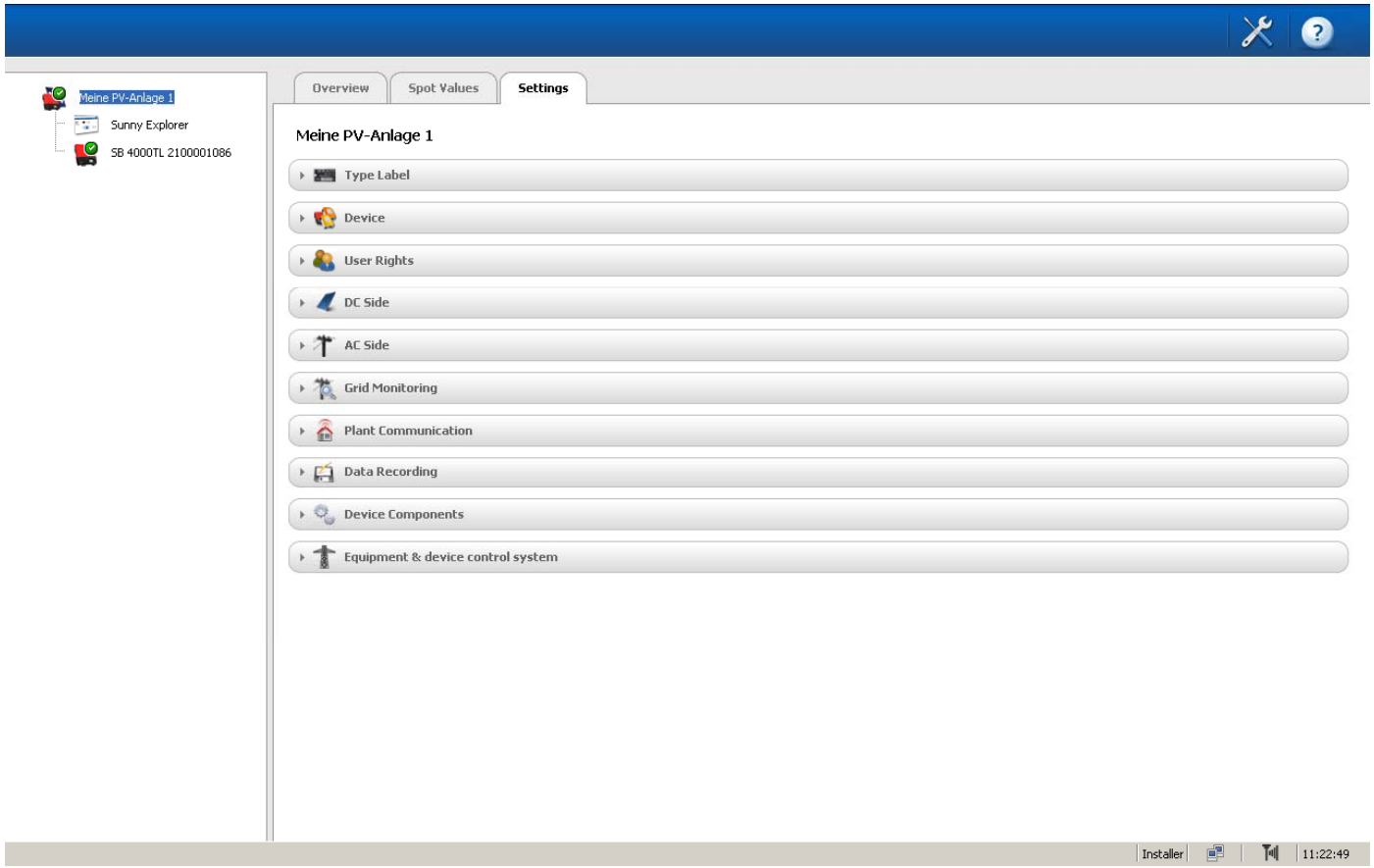


Changing parameters with Sunny Data Control



System monitoring – Sunny Explorer


Meine PV-Anlage 1
Sunny Explorer
SB 4000TL 2100001086
Overview
Spot Values
Settings
Meine PV-Anlage 1
Meine PV-Anlage 1
Solar Inverters
Condition Ok
Communication products
Condition Ok
Day
Month
Year
Total
Daily Performance
5 kW
4 kW
3 kW
2 kW
1 kW
0 kW
0:00
4:00
8:00
12:00
16:00
20:00
03.01.2012
Installer
11:21:51


Meine PV-Anlage 1
Sunny Explorer
SB 4000TL 2100001086
Overview
Spot Values
Settings
Meine PV-Anlage 1
Type Label
Device
User Rights
DC Side
AC Side
Grid Monitoring
Plant Communication
Data Recording
Device Components
Equipment & device control system
Installer
11:22:49

SUNNY EXPLORER – An overview of the advantages

> Quick overview of the status of the PV plant

> Safe data transfer through new password system

> Yield overview at a glance

> Graphical display of key system data

> Intuitive interface

> Wireless monitoring of the PV system with Bluetooth technology

> Free PC software for use on your existing PC

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Let's be realistic
and try the impossible!

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Be a solar expert